

NASA's Earth Science Enterprise



**ESE Focus for the Next Decade:
Improving the ESE Capability to
Deliver
Science and Applications Results
to the Nation**

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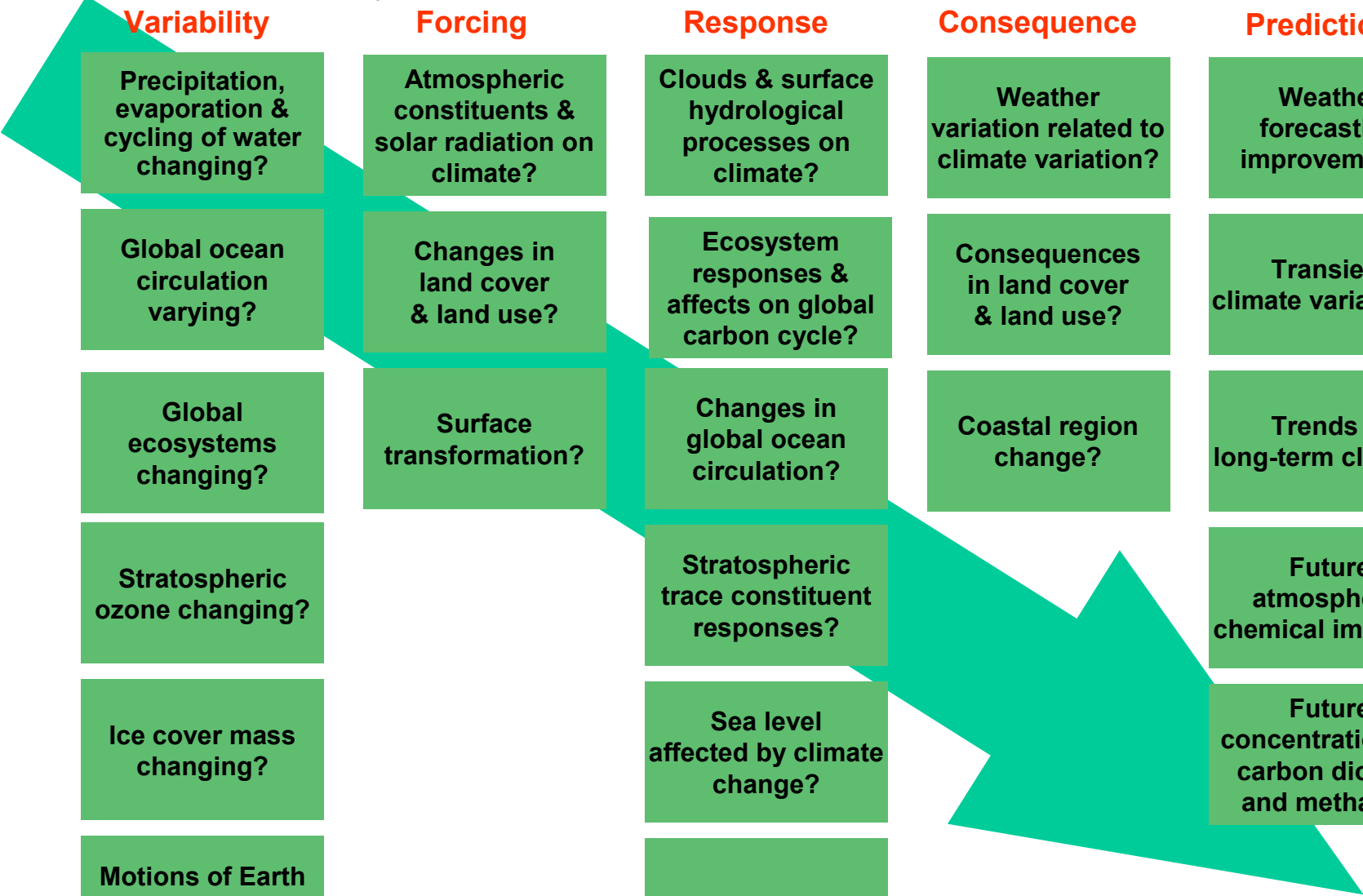
The NASA Vision

To improve life here,
To extend life to there,
To find life beyond.

The NASA Mission

To understand and protect our home planet,
To explore the universe and search for life,
To inspire the next generation of explorers
... as only NASA can.

Science Questions from the Research Plan



Variability	Forcing	Response	Consequence	Prediction
Precipitation, evaporation & cycling of water changing?	Atmospheric constituents & solar radiation on climate?	Clouds & surface hydrological processes on climate?	Weather variation related to climate variation?	Weather forecasting improvement?
Global ocean circulation varying?	Changes in land cover & land use?	Ecosystem responses & affects on global carbon cycle?	Consequences in land cover & land use?	Transient climate variations?
Global ecosystems changing?	Surface transformation?	Changes in global ocean circulation?	Coastal region change?	Trends in long-term climate?
Stratospheric ozone changing?		Stratospheric trace constituent responses?		Future atmospheric chemical impacts?
Ice cover mass changing?		Sea level affected by climate change?		Future concentrations of carbon dioxide and methane?
Motions of Earth & interior processes?		Pollution effects?		

Earth Science National Applications



**Carbon
Management**



Public Health



Energy Forecasting



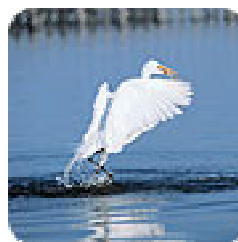
Aviation Safety



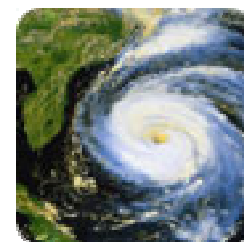
**Water
Management**



**Homeland
Security**



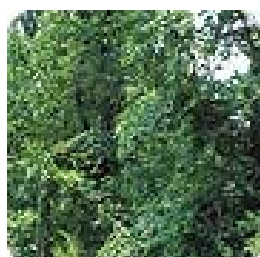
**Coastal
Management**



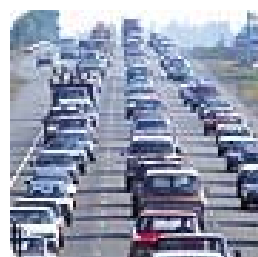
**Disaster
Preparedness**



**Agricultural
Competitiveness**



Invasive Species



Community Growth

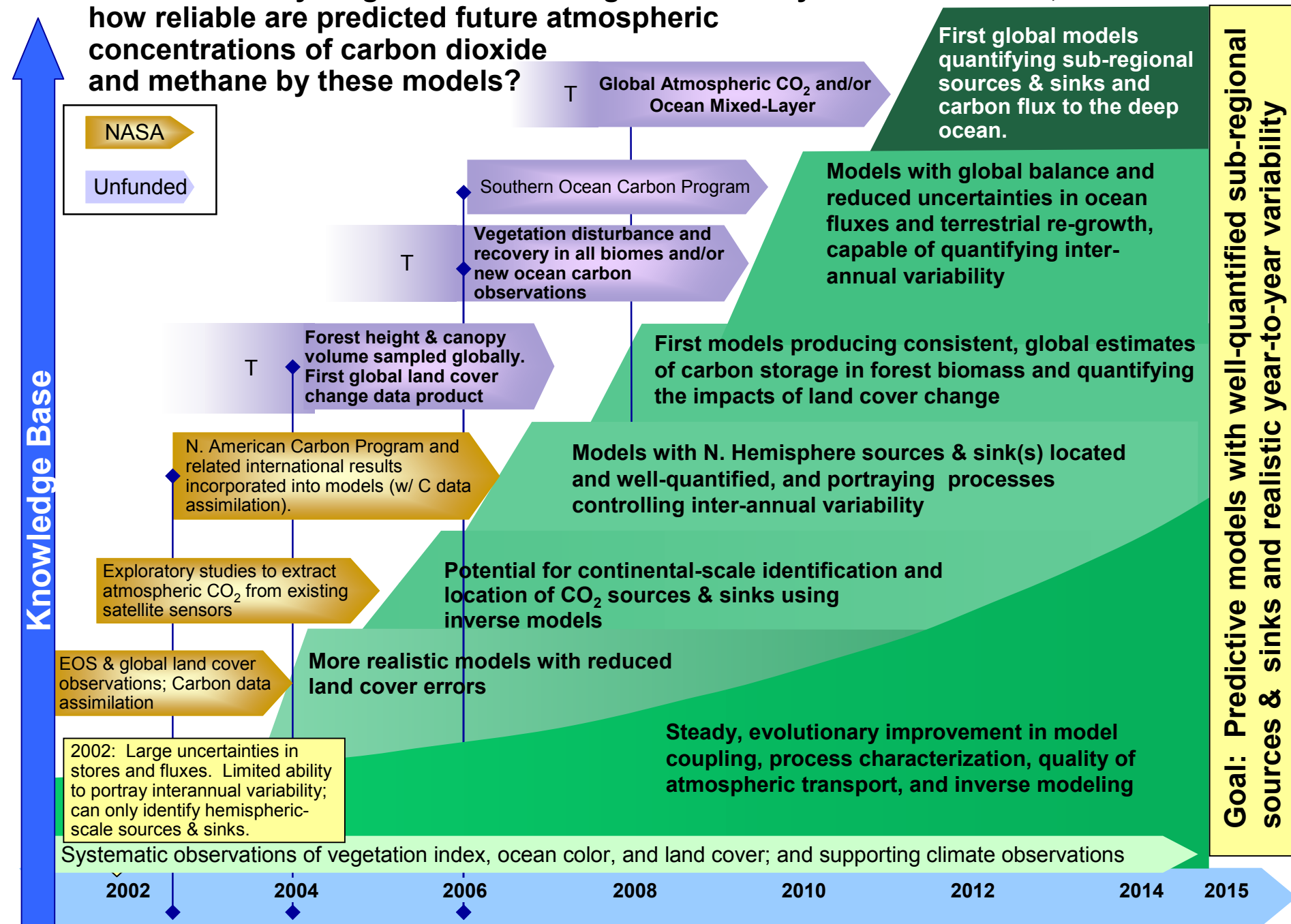


Air Quality

Implementing Science for Society

- **Engaging society in the Earth science enterprise is facilitated by identifying a concise set of important objectives within a framework of critical focus areas.**
 - **Current focus areas include:**
 - Atmospheric Composition
 - Atmospheric Dynamics and Weather
 - Global Carbon Cycle and Ecosystems
 - Global Water and Energy Cycle
 - Oceans, Ice and Climate
 - Solid Earth Science

How well can cycling of carbon through the Earth system be modeled, and how reliable are predicted future atmospheric concentrations of carbon dioxide and methane by these models?





How is Global Sea Level Affected by Climate Change?

Knowledge Base

= Airborne ice surveys

NASA

Joint

Unfunded

IPCC
Report

GODAE
CLIVAR

Sea Surface Salinity Mission

Ocean Vector Winds Mission

US SAR Mission

Model-based Integrated
Satellite Data Analysis

Global Ocean Data
Assimilation Experiment

ICESat

GRACE &
Jason

FY04 Performance Outcome:

High resolution ice elevation maps for modeling;
Integrated Topex/Jason sea-level time-series
First-order sea ice thickness assessments

Continued tide gauges, buoys, and meteorological observations

IPCC
Report

NASA Sea Level
Assessment

ICESat Follow-on
GRACE Follow-on

Integrated ocean observing system for
analysis of subsurface heat, salt, and
wind effects to understand sea level

Estimates of glacier and ice sheet discharge
into ocean; improved capabilities for
modeling ice mass changes

Synthesis of Gravity, land-ice elevation,
and ocean elevation data for relative sea
level rise contributions

Observationally enhanced model
improvements of Earth/Ice/Ocean/Climate
interactions

Observations of ice mass changes, gravity and
ocean topography enable identification of their
relative contribution to of sea-level rise

Ongoing model improvements

Regional sea
level rise prediction
capability

Validated crustal, ice
and ocean models for
analysis of global and
regional sea level

2002

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012



Air Quality Management: Clean Air Standards and Air Quality Forecasts

DRAFT

EPA CMAQ & Forecasts by 2012:

- Robust emissions control planning
- Routine warnings of pollution events
- 3-day air quality forecasts

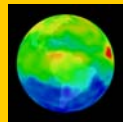
Prevent:

- 15,000 premature deaths/year
- \$5-10 B reduced crop yields

Primary Partners:



- Day/night chemistry/transport
- Trace gas measurements
- Boundary layer resolution



Outcomes: Improved pollution forecasts. Improved national emissions control planning/mitigation.

Impacts: Reduce major illnesses and deaths from air pollution episodes.

AURA - TES

- Global/regional/local distribution of ozone
- Tropospheric mixing & B.L. interaction

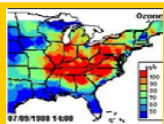


Outcomes: Source & destination of long-range dust & pollutants. Route airplanes. Issue health alerts and NAAQS waivers.

Impacts: Reduce wear on airplanes and engines. Improve crop estimates for international markets.

AURA - OMI

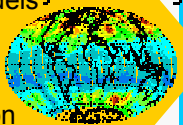
- Ozone profiles/transport
- Build on TOMS & GOME
- Aerosol & trace gas characteristics



Outcomes: Assess development policies to achieve or maintain compliance. Improve forecasts of PM and pollution episodes. Warnings to hospitals & farmers.

Impacts: Reduce lung related diseases (asthma, bronchitis, pneumonia). Improve visibility. Improve crop health & yields.

- Coupled chemistry-aerosol models
- Optical depth data
- Continental inflow/outflow
- Robust satellite data assimilation



Outcomes: Quantify contributions of physical & chemical processes to pollutant concentrations. Improve ozone forecasting and regional transport.

Impacts: Reduce impaired lung function and use of medications. Reduce hospital admissions and lost work/school days.

- Validations
- Ozone residuals
- Better boundary conditions



Outcomes: Assess effects of emission control options. Evaluate development options and emission strategies to set policies and construct SIPs.

Impacts: Improve economic development opportunities within States and Regions.

CMAQ / Forecasts (c. 2002): State/regional planning. Same-day air quality predictions.



*Current trajectory:
Steady improvement in chemistry-transport models and pollution episode warnings.*



TOMS



GTE



Aqua



AERONET



Aura



CloudSat



CALIPSO



* Total Column



*NPOESS

* Pre-formulation

2000

2002

2004

2006

2008

2010

2012

Socioeconomic Impact

Improved capabilities to air quality management tools to assess, plan and implement emissions control strategies & improve air quality forecasts.

From Science to Societal Impact (and Back Again)

Education

Earth Science &
Technology

Inputs

Outputs

Outcomes

Impacts

**Earth
Science
Questions**

**Science
Community
Input**

**Measurements
& Monitoring**

- Satellites
- Sub-orbital
- Surface-based

Models

**Data
Products**

**Scientific
Discovery**

Assessments

**Decision
Support
Tools**

**Education
Tools**

**New
Understanding**

**Policy
Decisions**

**Management
Decisions**

**Future Scientists
& Engineers**

**New
Instruments
& Platforms**

**Computational
Modeling
Capability**

Visualization

**Adaptation to
Users' Systems**

Technology

Applications

ESE Needs for the Next Decade

- Science For Society
 - Providing decision makers with dependable, objective Earth Science knowledge to improve quality and sustainability of life
- ESE Roadmaps are improving our focus on science and applications products/results
 - Shifting our focus from missions and mission-defined data sets to answering key scientific questions
 - Building and utilizing consistent long-time series climate data records for key parameters identified in the roadmaps
 - Delivering the objective information, knowledge, and services needed by policy makers and decision makers in a timely and accurate manner